

i. Cost of field control surveys.

(1) Salaries. Use mean hourly rates from Table C-11.

Personnel	Hours	Rate	Cost
Party Chief	222	\$14.36	\$ 3,188
Instrument Worker	222	\$11.44	\$ 2,540
Rod/Chain Person	222	\$ 9.12	\$ 2,025
Computer Operator	16	\$15.75	\$ 252
Drafter	16	\$11.97	\$ 192
(10% of Others' Hours)	70	<u>\$21.48</u>	<u>\$ 1,504</u>
Hourly Rate Costs			\$ 9,449
Overhead on Labor (133.77%)			<u>\$12,640</u>
Total Labor Cost			\$22,089

(2) Adjustments to field survey. There are at least two factors to be considered that may impact the field survey effort:

(a) Inclement weather. This project is located in the Midwest, where the normal weather patterns can be expected to include about 1 day per 2 weeks of adverse weather conditions.

(b) Limiting field conditions. A number of situations in the field can cause time extensions to the field work, such as woods, dense culture, steep terrain, and limited access.

(3) Direct cost. In this example, the main direct costs include vehicle mileage and per diem for field survey crew members. Mileage normally costs about \$0.25 per mile. Per diem allowances vary, depending upon cost of housing and meals in specific areas. Typically, established Federal JTR rates are used for these estimates.

Direct Cost Item	Units	Unit Cost	Cost
Mileage	2,000	\$ 0.25	\$ 500
Per Diem	90	\$60.00	<u>\$5,400</u>
Total Direct Cost			\$5,900

j. Cost of field control surveys.

Labor	\$22,089
Direct	\$ 5,900
Production Costs	<u>\$27,989</u>
Inclement Weather (10%)	\$ 2,799
Adverse Conditions (7%)	<u>\$ 1,959</u>
Subtotal	\$32,747
Profit (12.1%)	<u>\$ 3,962</u>
Cost of Field Control Surveys	<u>\$36,709</u>

k. Costing aerotriangulation.

(1) Rather than itemize costs for aerotriangulation operations, most mappers charge a flat fee (usually \$70 to \$80 per photo) for this procedure.

(2) Aerotriangulation costs:

36 photos @ \$75 = \$2,700

l. Costing digital mapping. Compilation of digital mapping data, in most situations, is the single most costly function in a mapping project. Estimating production hours is very subjective depending upon the density of planimetric culture and complexity of terrain character. Subsequent figures in this appendix may be used as aids in estimating compilation rates.

(1) Precompilation. Prior to commencing field surveys, field control points must be selected on the control photos. In this situation, targets were set rather than selecting photoidentifiable image points. This time would be used to plan a preflight target pattern. The time needed for photo control planning:

No. models \times 0.25 hr ea = $32 \times 0.25 = 8$ hr

(2) Control data entry. Once field surveys and aerotriangulation have been accomplished, photo control data must be entered into the data base. This can be typed in manually or entered via a data disk. The time needed for photo control input:

No. models \times 0.25 hr = $32 \times 0.25 = 8$ hr

(3) Model orientation. Prior to collection of digital mapping data, the stereomodels must be oriented to the photo control data. Aerotriangulation should locate and correct errors in field surveys, so for stereomodels that have been analytically bridged, 0.5 hr should be sufficient to orient stereomodels in analytical plotters. In cases of conventional control problems and analog plotters, up to one full hour may be in order. The time needed for stereomodel orientation:

No. models \times (0.5 to 1.0 hr) = $32 \times 0.5 = 16$ hr

(4) Photogrammetric digital data collection. Two major items are considered in estimating times to compile mapping data: planimetric features and terrain character. Because of varying intricacy from site to site, they should be considered and estimated separately.

(5) Planimetric Density:

(a) Make a copy of the portion of the USGS quadrangle containing the mapping area.

(b) Outline major areas of comparably developed cultural features similar to those shown in Figure C-30.

(c) Using the *Culture Density Classification Template* shown in Figure C-31, estimate the percentage of cultural buildup at each level. The relative percentages are shown in Figure C-30 (i.e., 10 and 80 percent levels).

(d) With the aid of a polar planimeter, digitizing tablet, or a systematic/random pattern dot grid, measure the acreage of each density level as depicted in Figure C-30.

(e) Referring to Figure C-32, use the 1 in. = 100 ft line to interpolate the number of tenths of hours of compilation time required for planimetric density levels selected above.

(f) Enter pertinent information from items above into the tabular summary below. Multiply Acres/Type by Hours/Acre to complete summary.

Density	Mapping Planimetric Features		
	Acres/Type	Hours/Acre	Hours/Type
10	3,750	0.05	187
80	250	0.37	<u>92</u>
	Total Planimetric Data Hours		279

(6) Terrain Slope.

(a) Make a copy of the portion of the USGS quadrangle containing the mapping area.

(b) Outline major areas of comparable terrain slope as shown in Figure C-33.

(c) Using the *Terrain Slope Density Classification Template* shown in Figure C-34, estimate the slope factor of terrain for each area outlined in Figure C-33 (i.e., 15, 35, and 55 percent estimates of relative gradient).

(d) With the aid of a polar planimeter, digitizing tablet, or systematic/random pattern dot grid, measure the acreage of each slope level (i.e., the area of the 35 and 55 percent relative gradients shown in Figure C-33).

(e) Referring to the 2-ft contour line in Figure C-35, interpolate the number of tenths of hours required for each slope density level selected above.

(f) Enter pertinent information from items above into the tabular summary below. Multiply Acres/Type by Hours/Acre to complete summary.

Slope	Mapping Topography		
	Acres/Class	Hours/Acre	Hours/Type
15	1,500	0.08	120
35	1,350	0.17	230
55	1,150	0.25	<u>289</u>
	Total Topographic Data Hours		639

(7) Digital data editing. After the digital data are compiled, it is then necessary to perform an edit operation on the mapping data base. The amount of editing time can vary considerably, depending on production system and application, but it normally runs between 60 to 100 percent of stereocompilation time. Estimators should consult with contractors or other mapping agencies to determine what editing surcharge will best fit specific operations. In this situation, the mapping data appear to be relatively clean and straightforward, so an edit percent surcharge of 70 percent is used in the estimate. The time needed for editing stereomapping digital data:

$$(\text{plan hours} + \text{topo hours}) \times 70\% \text{ edit} =$$

$$(279 + 639) \times 70\% = 643 \text{ hr}$$

(8) Data format translation. Configurations of photogrammetric mapping systems vary widely. For example, if the stereoplotter collects data in ASCII format and the user CADD is AutoCAD, then data must be translated into Drawing Interchange File (DXF) format before entering the user system. In this case, data must be translated, and this operation is a cost item that must be included. Some systems may be interfaced to the specific CADD system (AutoCAD, Intergraph) of the data user; thus, the data coming from the stereoplotter to the CADD may need no further processing. Also during this operation, the editor may configure the data base into specific sheet data. Hours for this function can vary. Here again, the estimator should consult with contractors or other mapping agencies to determine percentage surcharges required for this phase of the work. In this example, a 5 percent surcharge is employed for data translation. The time needed for digital data translation: $5\% \times \text{mapping hours} = 46 \text{ hr}$.

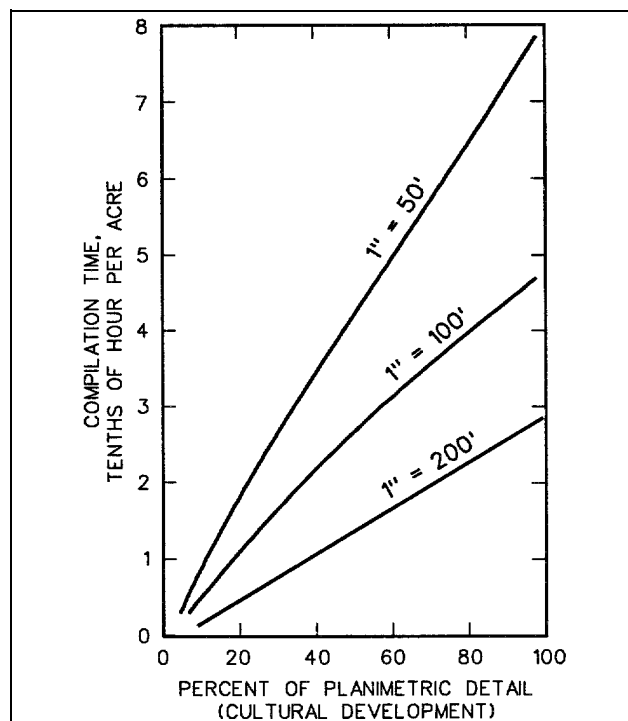


Figure C-32. Planimetric compilation mapping hours per acre given varying cultural densities

(9) Hard copy data plots. As part of the data collection package, at least three sets of hard copy map sheets should be plotted:

- (a) Preliminary edit.
- (b) Final edit
- (c) Delivery data plot.

In this example, a 28- × 40-in. ANSI F-Size sheet with a 25- × 37-in. neat mapping area will be used. The estimator should measure gross dimensions and divide by 2,500 ft north-south and 3700 ft east/west. To calculate the number of map sheets:

$$\left(\frac{\text{NS length}}{2,500} \right) \left(\frac{\text{EW length}}{3,700} \right) = \left(\frac{17,000}{2,500} \right) \left(\frac{13,000}{3,700} \right)$$

= 28 sheets

m. Production hours for digital mapping.

Phase	Stereo Compiler	Data Editor	Computer Operator
Control Planning	8		
Survey Input	8		
Model Setup	16		
Digital Data			
Planimetric	279		
Topographic	639		
Data Edit		643	
Translation			46
Total Hours	950	643	46

n. Cost of digital mapping. Use mean hourly rates from Table C-12.

Personnel	Hours	Rate	Cost
Stereocompiler	950	\$11.26	\$10,697
Data Editor	643	\$10.48	\$ 6,739
Computer Operator	46	\$15.78	\$ 726
Supervision:			
Chief Photogrammetrist (3% of Production Hours)	49	\$19.43	\$ 952
Photogrammetrist (7% of Production Hours)	115	\$16.42	\$ 1,888
Hourly Rate Costs			\$21,002
Overhead on Labor (163.87%)			\$34,416
Total Labor Costs			\$55,418

o. Direct cost. Use mean direct cost item rates from Table C-13.

Direct Cost Item	Units	Cost/Unit	Cost
Diapositives	36	\$ 4.00	\$ 144
Prelim Data Plot	56	\$20.00	\$ 1,120
Delivery Data Plot	28	\$20.00	\$ 560
Analytical Plotter (Data Collection)	918	\$15.54	\$14,266
CADD (Data Editing) Computer	729	\$11.65	\$ 8,493
(Data Translation)	47	\$10.00	\$ 470
Direct costs			\$25,053
Labor + Direct			\$80,471
Profit (11.29%)			\$ 9,085
Cost of Digital Mapping			\$89,556

p. Total estimated project cost.

Aerial Photos	\$ 1,428.00
Field Control Survey	\$ 36,709.00
Aerotriangulation	\$ 2,700.00
Digital Mapping	\$ 89,556.00
Total Project Cost	\$130,393.00

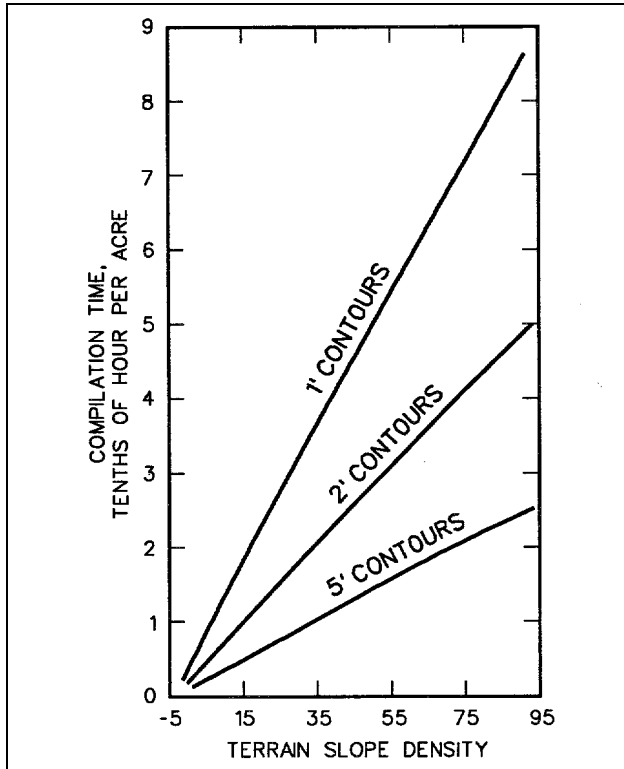


Figure C-35. Topographic compilation mapping hours per acre given varying terrain character classifications

q. Comparison to budgetary cost. It is noted that a budgetary cost was estimated for this same project in paragraph C-30.

C-45. Exercise Number 3: Cost Estimate For Design Mapping with Orthophoto Image

a. Project. In this example it is desired to obtain Class 1 mapping to collect digital data for earthwork excavation and placement for road construction. The digital data will also be used for utility design on a park site fronting a proposed lake. Also, Class 2 orthophoto image sheets will be produced to scale 1 in. = 100 ft for facilities layout use. The project area is shown on the map in Figure C-36, which is copied from a portion of a 1:24,000 USGS quadrangle.

b. Procedure. As the estimating process progresses, it will become evident that the following functions will be required in this effort:

- (1) Acquire aerial photography.
- (2) Accomplish skeletal field control surveys.



Figure C-36. Site map for design mapping and orthophoto project

- (3) Generate photo control with aerotriangulation.

(4) Collect digital mapping data in DTM format and produce a hard copy line drawing to a scale of 1 in. = 50 ft; planimetric and topographic digital data to USACE Class 1 accuracy standards (see Chapter 2).

(5) Generate orthophoto negatives and produce Class 2 orthophoto image sheets to a scale of 1 in. = 100 ft.

c. Defined parameters. At this point a number of parameters can be defined:

(1) Contour interval. Tables C-14, 2-4, and 2-5 indicate appropriate CI for earthwork computations and final design is 1 ft.

(2) Camera. A 6-in. focal length camera will be used.

(3) Photo control. Mapping area is predominantly undeveloped, so identification of sufficient photo control points that could be selected on the image is limited. Hence, aerotriangulation is indicated. Class 1 mapping limits bridging spans (Table 6-1) to:

- (a) Two models for vertical.
- (b) Four models for horizontal.

(4) Photo scale. In this situation, two considerations are important: vertical accuracy of topographic data and horizontal accuracy of orthophoto imagery.

(a) Topographic. USACE Class 1 mapping standards limit C-factor for analytical stereoplotter to a maximum value of 2000 (Table 2-7). Aerotriangulation will be performed, so a deformation in the vertical accuracy of the bridged photo control points can be expected. Allow a 5 percent accuracy degradation for each of the two models spanned.

Revised C-factor = $2000 \times (100\% - 10\%) = 1800$

Flight height = C-factor \times CI
 $= 1800 \times 1 = 1,800$ ft

Photo scale = $\frac{\text{flight height}}{\text{focal length}} = \frac{1800}{6}$
 $= 300$ or 1 in. = 300 ft

(b) Orthophoto image. Class 2 orthophoto imagery limits maximum enlargement factor, from photo scale to orthophoto image sheet scale, to six times (Table 9-1). Hence, photo scale is computed as:

map scale denominator \times enlargement factor =
 $100 \times 6 = 600$ or 1 in. = 600 ft

(c) This project should be flown at both scales.

(5) Overlap. Image area of a standard aerial photograph measures 9 x 9 in.

Scale	1 in. = 300 ft	1 in. = 600 ft
Gross Image Coverage	2,700 ft \times 2,700 ft	5,400 ft \times 5,400 ft
Endlap (30% Forward Overlap) (Between Consecutive Exposures)	1,080 ft	2,160 ft
Sidelap (70%) (Between Adjacent Flight Lines)	1,890	3,780

(6) Flight lines.

(a) Mapping flight:
Number of flight lines = $\frac{\text{project width}}{\text{sidelap gain}} = \frac{3200}{1890}$
 $= 1.69$ lines

which necessitates two lines as shown in Figure C-37a.

(b) Orthophoto flight

Number of flight lines = $\frac{\text{project width}}{\text{sidelap gain}}$
 $= \frac{3200}{3700} = 0.85$ line

which necessitates one line as shown in Figure C-37b.

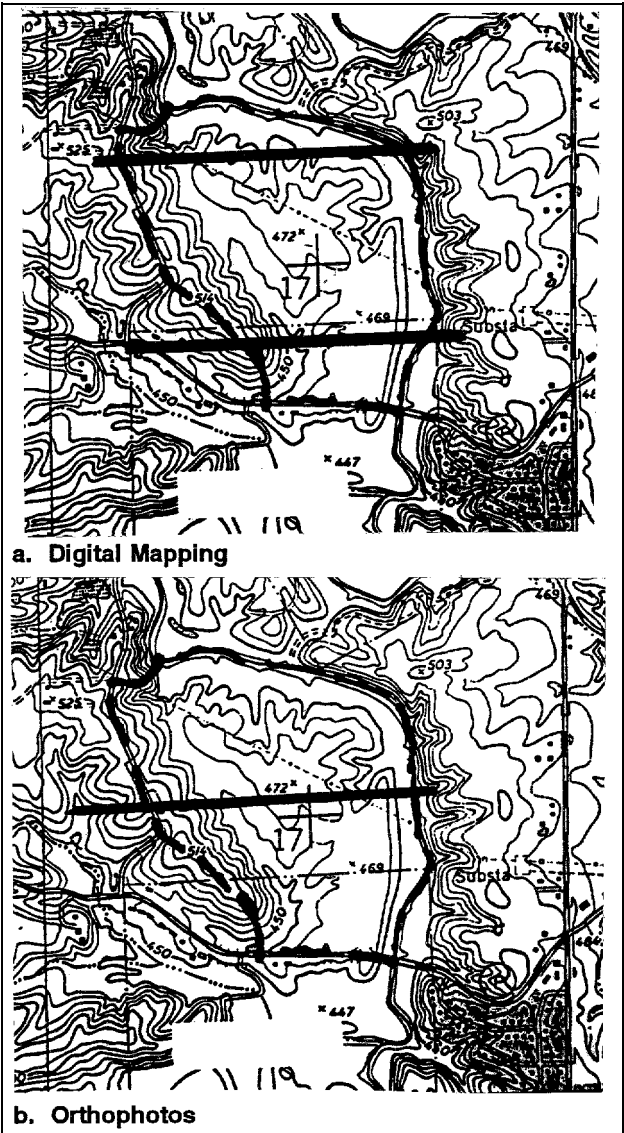


Figure C-37. Flight line layouts

(7) Number of photos.

(a) Mapping flight:

<u>Line</u>	<u>Length, ft</u>	<u>Photos</u>
1	3,600	4
2	3,600	4

Allow an additional photo for each line to assure stereoscopic coverage, which results in a total of 10 photos.

(b) Orthophoto flight:

<u>Line</u>	<u>Length, ft</u>	<u>Photos</u>
1	3,600	4

Allow an additional photo for the one flight line to assure stereoscopic coverage, which results in a total of three photos.

d. *Estimating photo mission time.*

(1) Ground preparation. Allow 1 hr per day.

(2) Flying time. Table C-13 indicates an aircraft rental rate of about \$255. Inserting this value into the line graph in Figure C-26 results in a cruising speed of 150 miles per hour.

(a) En route time, assuming for this project that the aircraft is hangered 100 miles from the project:

$$\frac{100 \text{ miles} \times 2 \text{ ways}}{150 \text{ mph}} = 1.3 \text{ hr}$$

(b) Photography. The following times are estimated:

Mapping Flight for Lines	0.2 hr
Changing Altitude	0.2 hr
Ortho Flight	<u>0.1 hr</u>
Total	0.5 hr

(c) Total flying time:

$$\text{En route} + \text{photography} = 1.3 + 0.5 = 1.8 \text{ hr}$$

e. *Production hours for aerial photography.*

Phase	Pilot	Photographer	Lab Tech	Aircraft
Flight Plan	1.0			
Ground Prep	1.0	1.0		
En Route	1.3	1.3		1.3
Photography	0.5	0.5		0.5
Processing			<u>2.0</u>	
Total	<u>3.8</u>	<u>2.8</u>	<u>2.0</u>	<u>1.8</u>

f. *Cost of aerial photography.* Use mean labor rates from Table C-15.

Personnel	Hours	Rate	Cost
Pilot	3.8	\$15.42	\$ 59
Photographer	2.8	\$13.00	\$ 36
Lab Tech	2.0	\$10.84	\$ 22
Supervision (10% of Others' Hours)	1.0	<u>\$24.08</u>	<u>\$ 24</u>
Hourly Rate Costs			\$141
Overhead on Labor (163.87%)			<u>\$231</u>
Total Labor Cost			\$372

Use mean direct costs from Table C-13.

Function	Units	Unit Cost	Cost
Aircraft	1.8	\$255.00	\$459
Contact Prints (2 sets)	30.0	\$ 3.00	\$ 90
Aerial Film (panchromatic)	15.0	\$ 1.20	\$ 18
Film Processing	15.0	\$ 0.60	<u>\$ 9</u>
Total Direct Cost			\$576

Labor + Direct	\$ 948
Profit (11.29%)	<u>\$ 107</u>

Cost of Aerial Photography \$1,055

g. *Field control surveys.* Costing field surveys is an individual concept. The estimator must draw on some personal knowledge of survey procedures. Lacking that, it would be well to confer with an experienced surveyor.

h. *Estimating field control hours.*

(1) En route travel: Assume that the office of the field surveyor is local to the project, so no en route travel is indicated.

(2) Offsite control references:

(a) For this project, it is assumed that there is an established triangulation station within 2 miles of the project site. A closed traverse should be run from the station to the site then tied back on the station. The time needed for horizontal control:

$$2 \text{ miles} \times 8 \text{ hr} = 16 \text{ hr per crew member}$$

(b) The quadrangle notes two benchmarks within 2 miles of the site. A level circuit is run from this station to the project, then closed back to either one of the two benchmarks. Vertical surveys should be accomplished by differential leveling to third-order standards. The time needed for vertical control:

$$2 \text{ miles} \times 8 \text{ hr} = 16 \text{ hr per crew member}$$

(3) Site reconnaissance: On a small open site such as this, 2 hr per crew member would be sufficient.

(4) Set targets. Refer to target diagram in Figure C-38 for proposed target pattern. The time needed to set targets:

$$9 \text{ targets} \times 0.5 \text{ hr} = 4.5 \text{ hr per crew member}$$



Figure C-38. Proposed target layout diagram

(5) Establish control points:

(a) Horizontal. The target diagram in Figure C-38 indicates that there are seven points, symbolized with triangles, for which coordinates will be established. It is critical that each of these coordinates be accurately surveyed. Each must be included in a closed horizontal traverse initiated and closed on known coordinates. The time needed to establish coordinates:

$$7 \text{ points} \times 2 \text{ hr} = 14 \text{ hr per crew member}$$

(b) The target diagram also indicates that there are nine points, symbolized with triangles and circles, for which elevations will be established. Since the project is set up to bridge photo control with a three-model span, it is critical that each of these elevations is correct. Each must be included in a closed level circuit initiated and closed on known benchmarks. The time needed to establish elevations:

$$9 \text{ targets} \times 2 \text{ hr} = 18 \text{ hr per crew member}$$

(c) Adjustments to survey time. A few items should be considered for adjusting field survey production. Since the crew will work out of the home office, there will be no need to consider inclement weather costs. Several situations could increase horizontal and vertical survey time—cultural development, woods (especially when foliage is present), and adverse terrain slopes. Individually, or in combination, these could increase survey time constraints. On this project example, there should be minimal culture and limited slopes and/or tree cover to interfere with control procedures; therefore, no additional control time is in order.

i. Production hours for field control surveys.

Phase	Party Chief	Instrument Worker	Rod/Chain	Computer Oper.	Drafts-person
Travel	0	0	0		
References					
Horizontal	14	14	14		
Vertical	16	16	16		
Reconnaissance	4	4	4		
Control Surveys					
Horizontal	16	16	16		
Vertical	18	18	18		
Targets	4	4	4		
Computations				8	
Sketches					8
Totals	72	72	72	8	8

j. Cost of field control surveys.

(1) Salaries. Use mean hourly rates from Table C-11.

Personnel	Hours	Rate	Cost
Party Chief	72	\$14.36	\$1,034
Instrument Worker	72	\$11.44	\$ 824
Rod/Chain Person	72	\$ 9.12	\$ 657
Computer Operator	8	\$15.75	\$ 126
Draftsperson	8	\$11.97	\$ 96
Supervision (10% of Others' Hours)	23	\$21.48	\$ 494
Hourly Rate Costs			\$3,231
Overhead on Labor (133.77%)			\$4,322
Total Labor Costs			\$7,553

(2) Direct cost. In this example the main direct cost would be vehicle mileage at about \$0.25 per mile.

Direct Cost Item	Units	Cost/Unit	Cost
Vehicle Mileage	250	\$0.25	\$63
Total Direct Cost			\$63

(3) Total estimated field control survey costs.

Labor + Direct	\$7,553
Direct	\$ 63
Survey Costs	\$7,616
Profit (12.1%)	\$ 922
Cost of Field Control Surveys	\$8,538

k. *Costing aerotriangulation.* In this example, rather than costing control bridging at a lump sum per model, the operation breakdown in Table C-16 will be utilized.

(1) Estimated hours: Use Table C-16 for function breakdown.

Function	Hours/Model	Models	Total Hours
Plans	0.50	8	4.0
Pugging	0.50	8	4.0
Comparator	0.35	8	2.8
Input	0.25	8	2.0
Computer	0.35	8	2.8
		Total	15.6

(2) Estimated cost. Use mean rates in Table C-12.

Personnel	Hours	Rate	Cost
Stereocompiler	10.8	\$11.26	\$122
Computer Operator	4.8	\$15.78	\$ 76
	Hourly Cost		\$198
	Overhead (163.87%)		\$324
	Total Hourly Cost		\$522
	Profit (11.29%)		\$ 59
	Total Cost		\$581

l. *Calculating digital mapping hours.*

(1) Precompilation.

(a) Control planning. Prior to commencing field surveys, field control points must be selected on the control photos.

$$\text{models} \times 0.25 \text{ hr} = 8 \times 0.25 = 2 \text{ hr}$$

(b) Control input. Once field surveys and aerotriangulation have been accomplished, photo control data must be entered into the data base.

$$\text{models} \times 0.25 \text{ hr} = 8 \times 0.25 = 2 \text{ hr}$$

(c) Model orientation. Prior to collection of digital mapping data, the stereomodels must be oriented to the

photo control data. Aerotriangulation should locate and correct errors in field surveys, so for stereomodels which have been analytically bridged, 0.5 hr should be sufficient to orient stereomodels in analytical plotters. In cases of conventional control problems or when using analog plotters, up to one full hour may be in order.

$$\text{models} \times (0.5 \text{ to } 1.0 \text{ hr}) = 8 \times 0.5 = 4 \text{ hr}$$

(2) Digital data stereomapping.

(a) Planimetric density: Refer to Figure C-39. Since this project is essentially rural, there would be only a single low-density cultural development class. Using Figure C-31, estimate the percentage of cultural buildup for this class. With the aid of a polar planimeter, digitizing tablet, or systematic/random pattern dot grid, measure the acreage of each density level. Referring to the 1 in. = 50 ft line in Figure C-32, interpolate the number of tenths of hours required for planimetric density levels. Enter pertinent information into the tabular summary below. Multiply Acres/Type by Hours/Acre to complete summary.

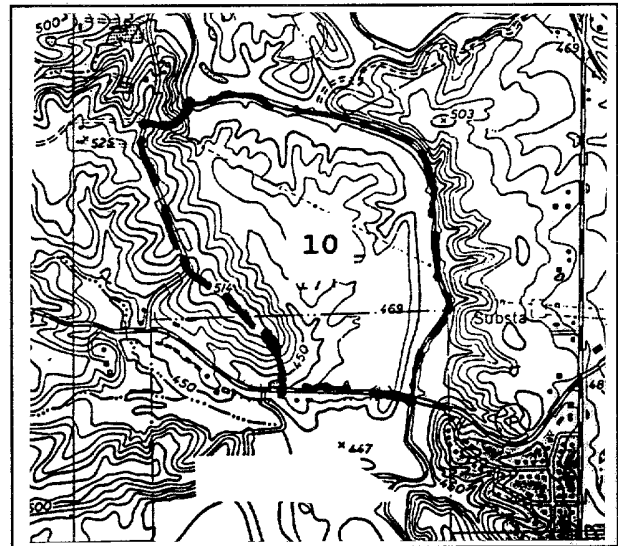


Figure C-39. Cultural density classification

Density	Acres/Type	Hours/Acre	Hours/Type
10	175	0.07	12

(b) Terrain slope. Make a copy of the portion of the USGS quadrangle containing the mapping area. Outline major areas of comparable terrain slope similar to that shown in Figure C-40. Using Figure C-34, estimate the terrain slope factor at each level. With the aid of a polar planimeter, digitizing tablet, or systematic/random

pattern dot grid, measure the acreage of each slope level. Referring to the 1-ft contour line in Figure C-35, interpolate the number of tenths of hours required for slope density levels selected. Enter pertinent information into the tabular summary below. Multiply Acres/Type by Hours/Acre to complete summary.



Figure C-40. Terrain slope classification

Slope	Acres/Class	Hours/Acre	Hours/Type
15	60	0.15	9
25	75	0.25	19
65	40	0.55	22
Total Topographic Data Hours			50

(3) Digital data editing. (See discussion under Example 2, paragraph C-44(7)).

$$(\text{plan hours} + \text{topo hours}) \times 70\% \text{ edit} =$$

$$(12 + 50) \times 70\% = 43 \text{ hr}$$

(4) Data format translation. (See discussion under Example 2, paragraph C-44(8)).

$$5\% \times \text{mapping hours} = 3 \text{ hr}$$

(5) Production hours for digital mapping.

Phase	Stereo Compiler	Data Editor	Computer Operator
Control Planning	2		
Survey Input	2		
Model Setup	4		
Digital Data			
Planimetric	9		
Topographic	50		
Data Edit		43	
Translation			2
Total Hours	67	43	2

m. Costing digital mapping. Use mean hourly rates from Table C-12.

(1) Labor costs.

Personnel	Hours	Rate	Cost
Stereocompiler	67	\$11.26	\$ 754
Data Editor (CADD Draftsman)	43	\$10.48	\$ 451
Computer Operator	2	\$15.78	\$ 32
Supervision:			
Chief Photogrammetrist	3	\$19.43	\$ 58
(3% of Production Hours)			
Photogrammetrist	7	\$16.42	\$ 115
(7% of Production Hours)			
Hourly Rate Costs			\$1,410
Overhead on Labor (163.87%)			\$2,311
Total Labor Costs			\$3,721

(2) Direct cost. Use mean direct cost item rates from Table C-13. In this example the stereoplotter will be analog. Hence, there will be no hourly rental of an analytical plotter. On the other hand, the analog plotter is also being used as a CADD system. Hence, hourly stereocompilation and editing time will be charged as CADD usage hours.

Direct Cost Item	Units	Cost/Unit	Cost
Diapositives	10	\$ 4.00	\$ 40
Preliminary Data Plot	4	\$20.00	\$ 80
Delivery Data Plot	2	\$20.00	\$ 40
CADD System			
(Data Collection)	62	\$11.65	\$ 722
CADD (Data Editing)	41	\$11.65	\$ 448
Computer			
(Data Translation)	2	\$10.00	\$ 20
Direct Costs			\$1,400
Labor + Direct			\$5,121
Profit (11.29%)			\$ 578
Cost of Digital Mapping			\$5,699

n. Producing ortho image sheets. Ortho negatives will be produced from the higher altitude photography.

(1) A double model (two consecutive ortho negatives without a visible seam in the match area) will be produced.

(2) A negative will be produced of the border sheet.

(3) A negative will be produced of the contour data plot.

(4) A positive copy will be produced by compositing the border and contour data plot, and overlaying the orthophoto image. This will require exposing each of three negative images onto each of the final sheets.

o. Costing orthophoto sheets.

(1) Orthophoto negatives. Some sources charge lump sum per model while some charge hourly rates for personnel and equipment. A cost in the neighborhood of \$200-\$250 per single model is realistic.

$$2 \text{ models} \times \$225 = \$450$$

(2) Orthophoto image sheets.

(a) Sheet border negative: \$50

(b) Orthophoto image sheet positives (this will require multiple exposures):

$$2 \text{ sheets @ } \$150 = \$300$$

(3) Orthophoto image sheet costs.

Orthophoto Negatives	\$ 450
Sheet Border Negative	\$ 50
Hard Copy Contour Data Plot	\$ 40
Contour Plot Negatives	\$ 64
Orthophoto Image Sheet Positives	<u>\$ 300</u>
Production Cost	\$ 904
Profit (11.29%)	<u>\$ 102</u>
Total Cost	\$1,006

p. Total estimated project cost.

Aerial Photos	\$ 1,055
Field Control Survey	\$ 8,538
Aerotriangulation	\$ 581
Digital Mapping	\$ 5,699
Ortho Image Sheets	\$ 1,006
Total Project Cost	<u>\$16,879</u>

C-46. Exercise Number 4: Cost Estimate For Photo Image Plan Sheets

a. Project. This project entails producing photo image plan sheets at a scale of 1 in. = 500 ft for general planning and land use/cover applications. The site requires bluff-to-bluff coverage bordering the stretch of the river indicated in Figure C-41, which is copied from a portion of a 1:250,000 USGS quadrangle.

b. Requirements and procedures. The following functions will be required:

(1) Obtain aerial photography suitable to fit on a 28- × 40-in. sheet with 25- × 37-in. neat image area.

(2) Gather appropriate control information to scale the photo image.

(3) Produce photo image sheets with appropriate border information.

c. Film. The image sheets are intended for reproduction as needed on a black-and-white copy machine. Fly panchromatic aerial photography.

d. Camera. Use a 6-in. focal length camera.

e. Photo scale. The image area width on a sheet is 25 in. × 500 ft = 12,500 ft, which, by measurement of maximum floodplain width on Figure C-41, allows all of the area of interest to fit on a single sheet width. A 5× enlargement factor will produce good quality image, so it is decided to fly at a photo scale of 1 in. = 2,500 ft.

f. Season. It would probably be best to fly this project in a foliage-free condition, which would allow for imagery with a pleasing range in gray scale. It would also permit visibility of the ground under vegetative cover. If flown in foliage seasons, image would exhibit more striking contrast and some ground features would be obscured.

g. Overlap. It would be advantageous to fly with 80 percent endlap. Each sheet could then be produced from the single photo best fitting that particular image area.

h. Relevant parameters.

(1) Flight height. The altitude of the aircraft (above mean ground level) will be:

$$\frac{1 \text{ in.}}{\text{scale}} = \frac{\text{focal length}}{\text{flight height}}$$

then

$$\frac{1 \text{ in.}}{2,500 \text{ ft}} = \frac{6 \text{ in.}}{\text{flight height}}$$

and the flight height = 6 × 2,500 = 15,000 ft above mean ground elevation.